Alternative Dwarfing Genes for Improving Seedling Establishment of Wheat

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Overview:
The time from sowing to emergence represents a key period in the development of high-yielding wheat crops. Commercially grown semidwarf wheats have the potential to produce high yields when sown shallow but can produce poor stands to reduce crop yields when sown deep. Current semidwarf, tall and CSERO-developed long coleoptile, semidwarf wheats were sown at Condobolin in 1999 at three depths (5, 8 and 11 cm). Deep sowing reduced plant number and vigour for all lines with the greatest reduction occurring for current semidwarf wheat varieties, Janz and Hartog. Seedling number was greater for tall wheats Halberd and Heron and long coleoptile, semidwarf breeding lines. In turn, tiller number at maturity was greater for long coleoptile wheats. Final yields were unaffected by deep sowing for tall and long coleoptile, semidwarf wheats whereas yield was reduced by 20% for deep-sown Janz and Hartog. Selected long coleoptile wheats are now being used in a backcross breeding program to introduce the long coleoptile trait into Australian commercial wheats.

Background

A good stand containing many plants will: promote rapid leaf area development to maximise light interception; compete more effectively with weeds; and 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 farming conditions. Older, standard-height wheat varieties such as Bencubbin and Stockade were selected to produce coleoptiles up to 13 cm in length whereas coleoptile length of current semidwarf 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 semidwarf wheat varieties stems from the presence of the *Rhtl* and *Rhtl* 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 (e.g. *Rhl8)* that decrease plant height to the- same extent of *Rhtl 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. This paper reports on a sowing depth study comparing growth and yield of long coleoptile-selected wheats with commercial tall and semi dwarf varieties at Condobolin in 1999.

Method

The experiment was sown at Condobolin on 16 June 1999 after fallow. Sowing depths were 5, 8 and 11cm. Adequate nutrients were supplied at sowing. Ten long coleoptile, reduced height lines were sown with representative tall (Halberd and Heron) and semidwarf (Janz and Hartog) varieties. The target population of plants at 5cm sowing depth was ca. 160 seed m"^{2}. The long coleoptile 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 reductions in the numbers of emerged seedlings of all tested lines (Figure 1). This reduction in plant number was largest for current semidwarf wheat varieties Janz and Hartog where only 38% of the number of seedlings counted at 5cm emerged at 11cm sowing depth. Reductions in plant number of the long coleoptile, semidwarf wheats were similar to the reduction in plant number for long coleoptile, tall wheats Halberd and Heron.

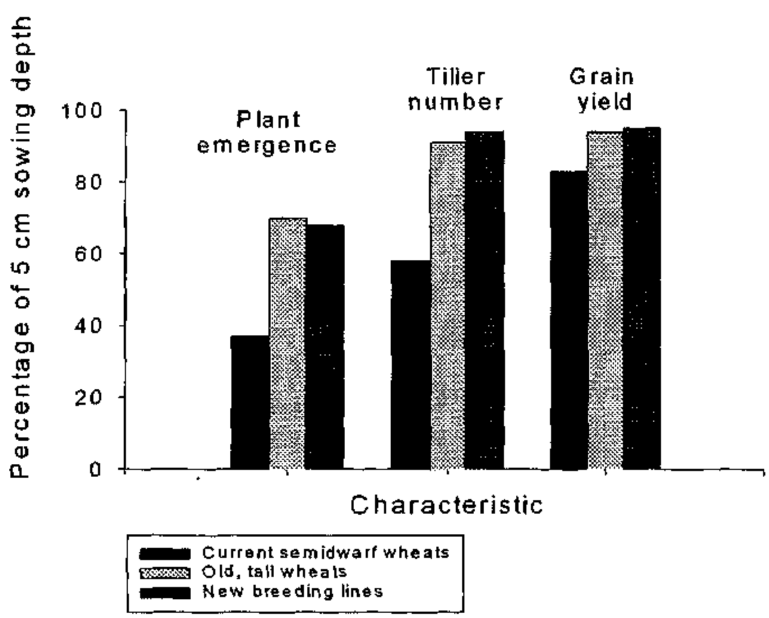

Figure 1. Seedling plant number, tiller number at maturity and final grain yield for representative semidwarf, tall and long coleoptile wheat breeding lines grown at 11 cm sowing depth. Units are expressed relative to observations at an optimal 5cm sowing depth.

Fewer seedling plants resulted in fewer tillers at anthesis and maturity. In turn, reduction in grain yield with deep sowing was smallest for long coleoptile wheats. Interestingly, grain yields were still high for deep-sown Janz and Hartog even though both varieties produced fewer tillers at maturity. Closer inspection of the data showed that Janz and Hartog did produce fewer kernels when deep-sown but were still able to compensate for fewer tillers by producing larger kernels. Production of fewer tillers and smaller biomass at flowering would have slowed water-use thereby saving water for grain-filling. Water saving would have been useful for maintaining kernel size given the very dry conditions up to flowering.

Interpretation

This experiment demonstrated the benefits of long coleoptile wheats for deep sowing. While there was some reduction in yield with deep sowing, the reduction in yield is likely to be much greater with short coleoptile, semidwarf wheats. Fewer tillers arising from a reduced number of emerged seedlings will limit yield in most environments. However, fewer tillers combined with dry conditions after emergence benefited Janz and Hartog by slowing water use at Condobolin in 1999.

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