Stem and ear growth in wheat and its effect on grain yield

K.H.M. Siddque[1], E.J.M. Kirby[2], M.W. Perry[1] and W.R. Stern[2]

[1] Western Australian Department of Agriculture, Baron-Hay Court, South Perth, 6151
[2] School of Agriculture, University of Western Australia, Nedlands, 6009 Experiments with historical and modern wheat varieties in Western Australia

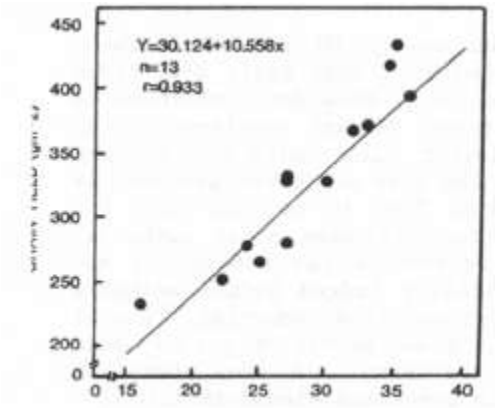
(M.W. Perry, unpublished data) have found that increases in grain yield in 'modern varieties have been associated with increases in grain number per ear and grain number per unit area. The cause of the increase in grain number per ear is not known, however the competitive relationships between stem and ear growth are believed (1) to determine spikelet fertility and hence grain number per spikelet and ear. Our study investigated the underlying causes of increased grain number per ear in a range of 'old' and 'modern' wheat varieties.

Methods

Two experiments, one at Shenton Park, Perth and the other at Wongan Hills Research Station were sown on May 28, 1986. Each included 13 historical (e.g. Purple Straw and modern cultivars (e.g. Kulin) plus 6 near-isogenic lines differing in rht dwarfing genes (Source, R.A. Richards, C.S.I.R.O., Canberra). The design was a randomised block with 5 replicates; plot size was 10 m by 1.44 m with 8 rows per plot. Aspects examined included leaf and spikelet initiation, growth of the ear and stem, grain growth and biomass, yield and yield components.

Results and Discussion

Analysis of data showed a two-fold increase in the rate of spikelet initiation frc the 'old' (e.g. Purple Straw, 0.323 spikelets day^{-1}) to 'modern' varieties (e.g. Kulin, 1.00 spikelets day^{-1}). There were some differences in number of spikelets per ear between varieties, but no trend (from the 'old' to the 'modern' varieties. There were strong correlations between number of leaves on the main shoot, the plastochron (1/rate of spikelet initiation) and time to the beginning of ear initiation. There were no consistent differences between genotype groups ('old' and 'modern') in the above ground biomass, ear number m^{-2} and 1000 grain weight. However grains per spikelet, grain number per ear, seed yield m^{-2}, harvest index and ear dry mass as a per cent of stem dry mass (i.e. ear/stem %) at anthesis were consistently higher with modern varieties. The incorporation of rht dwarfing gene in the near-isogenic lines increased the ear/stem % at anthesis, and this in turn increased grain number per ear and grain .yield. Observation on floret production showed that in most of the varieties florets per spikelets reached a maximum of 9 to 10. Thereafter, death of florets occurred, with the degree of floret death being related to the ear/stem % at anthesis. Consequently there was a strong correlation between ear/stem % at anthesis and grain yield (Fig. 1).



Ear as % of stem dry mass (at anthesis)

Fig. 1. Relationship between ear/stem % at anthesis and grain yield of historical and modern

The results suggest that partitioning of assimilate between stem and the ear affects ear development and hence yield potential, and the rht dwarfing gene affects this partitioning of assimilates in favour of the ear. Under normal conditions the cause of floret failure may be due to insufficient assimilate supply. This is likely to be related competition of the whole ear with the stem. This suggests that the way to further increase the grain yield of Australian wheat is to increase the size of the ear primordia relative to the stem at an earlier stage of development. This may be possible by incorporating rht dwarfing genes into the existing 'modern' wheat varieties and also further increasing the rate of initiation of both leaf and spikelet primordia.

3. Brooking, I.R., and Kirby, E.J.M. (1981). J. Agric. Sci. Canb. 97:373-81. wheat varieties at Wongan Hills