Physiological variation contributing to genotype by environment (water supply) interaction in Barley

Searle, K.S. Fischer and S. Fukai

Dept. of Agriculture, University of Queensland, St. Lucia. Qld. 4067

High and stable yields of barley depend on those characters and processes which contribute to high yield potential under favourable water supply (non specific adaptation) and on drought adaptive traits which allow for maximum grain yield under limited moisture supply (specific adaptation). This study examines the interrelation among characters associated with non specific and specific adaptation in barley.

Methods

Eighteen barley cultivars (18) of diverse origin were grown under irrigated and rainfed conditions at a single location. In the following year, a smaller set (8) were grown again under irrigated and rainfed conditions at three locations in SE Queensland. There then followed a glasshouse study with three cultivars where controlled moisture deficits were effected from flag leaf emergence to anthesis. Harvests of total dry matter (TDM) were made at flag leaf emergence, anthesis, mid grain filling and maturity, and its allocation to various tiller classes and inflorescences and grain determined. Water use in the field during the period flag leaf emergence to maturity was measured by neutron moisture meter. Leaf water potentials were also measured during the grain filling period.

Results and discussion

Under irrigation (where maximum yields ranged from 4.5-7.0 t ha ^{1}) there was considerable variation among entries in post anthesis dry matter production (PADM) and this was independent of flowering date. PADM exceeded grain yield in most 2 row cultivars but not in the 6 row ones. Thus in the former types yields are limited by the grain sink capacity.

Under dryland conditions PADM production varied among the cultivars, and was associated with water use during the period ($y=177+109x$ $r^{=}0.9$) there being little evidence, with the exception of one early flowering cultivar, of differences in water use efficiency. This water use was negatively correlated with TDM at anthesis. Grain yield was not always proportional to

PADM with some evidence of sink limitation and translocation. Cultivars differed in the number of grain to anthesis dry weight ratio, which was used as an index of efficiency of grain sink capacity (GSC). Mean stem size, synchronisation of tiller development (measured as the coefficient of variation in dry weights) and allocation of dry matter to the inflorescence, all influenced GSC but there was little variation in reproductive efficiency (g spike tissue grain) within the 2 row materials.

In the glasshouse study, where leaf water potentials were as low as -3.0 MPa, TDM was reduced by an average of 20% and the proportion of it allocated to the inflorescences in the larger and smaller tillers was reduced by 25 and 40%, respectively.

High and stable yield require cultivars with low anthesis TDM to maximise water availability for the production of grain filling assimilate, but with high GSC to ensure adequate grain sink.