

Identification and characterisation of water limiting environments within Queensland wheat breeding trials

M. Cooper¹, D.R. Woodruff² and D.E. Byth³

¹ Department of Agriculture, University of Queensland, St Lucia Q 4067

² Queensland Wheat Research Institute, P O Box 2282, Toowoomba Q 4350

³ Queensland Agricultural College, Lawes Q 4343

The objective of genotype selection in plant breeding trials is the identification of genotypes expressing improved adaptation to environments within a specified crop production system. The effectiveness of any selection experiment relies heavily upon the nature of genotypediscrimination within the environment and the relevance of the test environment to the crop production system. Therefore characterisation of breeding trial environments is an important component of interpreting and improving crop adaptation, defining the environmental challenge implicit within the breeding trial. This paper considers the use of three measurements, leaf water potential (LWP), osmotic potential (OP) and infra.red thermometer (IRT) air canopy temperature differentials, as techniques for assessing the water status of wheat breeding trial environments in Queensland.

Methods

Fifteen wheat genotypes were grown in four managed environments in which water availability was manipulated. Three environments were grown under rain.out shelters, low (LROS), medium (MROS) and high (HROS), and one was a fully irrigated (IRRIG) trial (Table 1). The rainout shelter plots were each four rows with 18 cm spacing by three metres, while the irrigated trial plots were four rows by 14 metres. All four trials were grown at Gatton, S E Qld during 1988. Between flag leaf emergence and anthesis LWP and OP measurements were taken on the flag leaf of each line in each environment. IRT readings were taken at flag leaf and a crop water stress index (CWSI) was calculated. Environment means were calculated for each set of measurements and related to site mean grain yield and grain yield components.

Results and discussion

Water stress around anthesis is considered a major limitation to wheat grain yield in Qld². Identification of the presence and extent of water limitation around anthesis in breeding trials could provide useful information for investigation of the adaptation of wheat genotypes in breeding trial series. Severe water stress at anthesis was detected by each water stress measurement in two environments, LROS and MROS. This was reflected in a reduction in grain number and grain size, reducing grain yield (Table 1). One environment, HROS experienced a mild water stress at anthesis but suffered no reduction in grain number or grain yield relative to the fully irrigated environment. The identification of presence or absence of anthesis water stress in this form of preliminary analysis provides a useful basis for investigation of genotype adaptation in these environments³. LWP, OP and IRT measurements were each useful in this environmental characterisation. The ease and speed with which the IRT could be used is a distinct advantage for characterising a large number of trials.

Table 1. Env. mean, grain yield, yield component and water status measurements for 15 genotypes in 4 envs

Measurement	Environment				LSD 5%
	LROS	MROS	HROS	IRRIG	
Irrigation	1 sowing	1 sowing	1 sowing	every	
Treatment		1 m-till	2 m-till	2 weeks	
Canopy /Air T°C	+1.94	+0.69	-0.60	-3.20	0.45*
CWSI	1.05	0.70	0.34	-0.21	0.13*
Pre-flag LWP MPa (m'day)	-2.31	-1.91	-1.43	-1.55	0.09*
Flag LWP MPa** (m'day)	-	-2.23	-1.72	-1.77	0.13*
Anthesis LWP MPa (m'day)	-	-2.99	-2.11	-1.77	0.11*
Flag OP MPa**	-	-1.80	-1.52	-1.36	0.21*
Anthesis OP MPa	-	-2.20	-1.65	-1.51	0.09*
Stress status	severe	severe	mild	none	-
Grain No. m ⁻²	6704.8	8007.9	11140.8	11453.0	650.8
Grain S g/200gr	7.04	7.32	7.45	7.58	0.17
Grain yield t/ha	2.37	2.92	4.15	4.34	0.25

* LSD does not apply to comparisons with HROS, ** Measurements taken on five genotypes.

1. Idso S.B., Jackson R.D., Pinter P.J., Reginato R.J. and Hatfield J.L. (1981). Agr. Met. 24, 45-55
2. Woodruff D.R. and Tonks J. (1983). Aust J. Agric Res, 34, 1-11
3. Cooper M., Woodruff D.R. and Byth D.E. (1989). An investigation of the adaptation of selected CIMMYT wheat germplasm to water limiting environments in Queensland. This volume.