

Evaluating stress tolerance to terminal drought by Western Australian wheats

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AIM

To evaluate the genetic diversity for escape from water deficits and heat during grain filling by accumulation of pre-flowering stem carbohydrates (CHO) with a focus on stress tolerance during grain filling in wheat grown in medium and low rainfall areas.

METHODS

Sow forty Western Australian/overseas varieties at three times-of-sowing at two locations over two year's (1997,1998) and measure stem carbohydrate weekly from pre-flowering until maturity. Develop and validate laboratory techniques for the measurement of CHO (1997, 1998).

Conduct several small trials (1998,1999) with a subset of varieties over a range of water stress and/or shaded conditions to validate whether CHO can be manipulated pre-grainfilling. Conduct two variety-screening trials at two locations over two years (1999, 2001) measuring CHO at several stages of plant development to identify 'high-storage CHO' varieties. Statistical Analyses used included one-way Analysis of Variance (ANOVA), Residual Maximum Likelihood (REML), and Principal Components Analysis (PCA) from S-PLUS Statistical Software.

RESULTS

- Variation was found amongst Western Australian germplasm (40 varieties) with remobilised stem CHO accounting for up to 25 to 35% of final grain yield for some varieties. Even greater diversity was found in stem CHO in ICARDA and CIMMYT lines showing CHO concentrations greater than 40% of dry weight.
- Agronomic factors were also found to influence stem CHO% with earlier sowings generally resulting in a reduction in the maximum stem CHO%.
- In general, later sowings result in higher levels of stem CHO. For the majority of the lines tested, high nitrogen (80 kg N/ha) as compared with standard fertiliser practice (40 kg N/ha) did not increase stem CHO concentrations with later sowings.
- In Western Australian varieties with similar carbon assimilation patterns, based visually on similar leaf chlorosis during grain filling, high stem CHO levels is highly correlated with high yields.
- High levels of CHO (5-10% CHO) at maturity in some high yielding Western Australian wheats (e.g. Westonia and Brookton), points to further potential for genetic/agronomic improvement by increasing grain numbers/ear.
- When selecting varieties with high yields, high concentrations of pre-flowering stem carbohydrates was found to be positively linked to high yield.
- Grain yield potential of low CHO types can be increased through manipulation of pre-flowering stem CHO one to two weeks before flowering. When supplementary light is used to experimentally increase stem CHO (i.e. by 50%) there is an equivalent increase (i.e. 50%) in grain yield (Perenjori).

Table 1. Carbohydrate storage classification for common WA varieties

Variety	CHO-storage	Maturity	Pedigree
Ajana	High	Early	Blade/2*Kulin
Bodallin	High	Early	Bokal/Siete Cerros
Westonia	High	Early	Spica Timgalen.Tosca/Cranbrook...Jacup*2.Bobwhite
Brookton	High?	Late	Torres/Cranbrook/Emblen.P1640..Nuri70/Cranbrook
Carnamah	Medium	Medium	Bolsena-1CH/77W:660 comp
Spear	Medium	Late	Sabre/Mec-3(RAC111)//Insignia
Tammin	Medium	Medium	Bodallin/3/Ciano/Gamenya/2/XBVT223/4/Atlas66/2*M adden
Tincurrin	Medium	Medium	Gluclub/3/Chile 1B/Insigna/Falcon
Arrino	Medium?	Medium	77W:660/Eradu
Calingiri	Medium?	Late	Chino/Kulin/Reeves
Camm	Medium?	Late	VPM1.5*Cook/4*Spear
Cunderdin	Medium?	Medium	Cranbrook sister/Sunfield sister
Silverstar	Medium?	Medium	Pavon"s"/(TM56) Cocamba sib
Wyalkatchem	Medium?	Medium	Machete/crossbred W84-129*504
Bt-Schomburgk	Low	Early	Halbert/Aroona/3*Schomburgh/Boron-tol-Schomburgh
Karlgarin	Low	Medium	Spear///((79W781)Bodallin/Eradu
Perenjori	Low?	Medium	Bodallin/Hyden

Note: '?' indicates likely classification.

CONCLUSION

These results suggest that varieties with a high-storage CHO capacity will give higher yields in normal years and much higher yields when there is a dry finish to the season.

KEY WORDS

stem carbohydrate, water deficits, wheat, stress tolerance

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