THE PHYSIOLOGICAL BASIS OF DROUGHT TOLERANCE IDENTIFIED FROM GENETIC ASSOCIATION ANALYSIS

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Introduction

Wheat is the most important cereal crop consumed world wide and a forecast population of 9.2 billion will require increased production of staple agricultural commodities to ensure global food security (Nelson *et al* 2010).

Plant breeding to improve the yield of wheat has mostly targeted increased adaptability to degraded environments and more efficient use of water and nutrients (Acuña, T. B.,et al 2015*)*.

Genetic mixtures can improve adaptation to abiotic stresses through the efficient utilization of resources including CO_2, water and light.

Conservation agriculture, or no tillage, has improved yields in some environments through greater water use efficiency, increased soil organic matter and soil structure improvement. Therefore, the development of drought tolerant cultivars with improved water use efficiency and appropriate phenology is paramount.

Objectives

(i) To determine key physiological traits possibly linked to genomic regions conferring high yield under moisture stress in an earlier genetic association analysis

(ii) Assess genotype x tillage x irrigation effects on the performance of these advance wheat lines on grain yield

(ii) Test the performance of selected wheat mixtures based on complementary genomic regions identified from association analysis against their pure stands under no-till and full tillage regimes in both irrigation/rain fed conditions.

Materials & Methods

(i) The study evaluated eighteen wheat cultivars together with 8 mixtures: these represent a subset of 216 advanced wheat lines originating from a commercial Australian wheat breeding program used in an earlier genetic association analysis (Babar et al., 2015).

(iii) Two tillage regimes (no-tillage & full tillage) and 2 irrigation regimes were tested and the trial was laid out in adjacent treatments using alpha lattice designs with three(3) replicates each.

(iv) Yield, Available Moisture, No. of Days to Heading, No. of Days to Physiological Maturity, Ground cover, Harvest index, Chlorophyll content and TKW were recorded

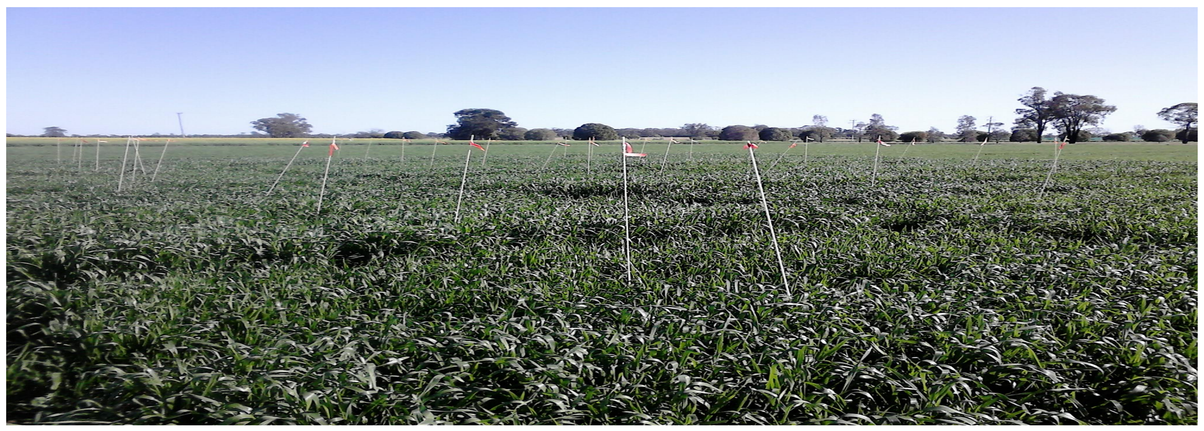

Fig 1. Fiber glass poles with flags indicating neutron probe access points in trial

Results

(i) Number of days to heading, Chlorophyll content, NDVI, biomass, Harvest index, canopy ground cover accounted for 81.2% of the observed genetic variance associated with yield.

(ii) Some mixtures had higher yield potential than individual pure line components.

Results

(iii) Results indicated significant differences among genotypes for response to tillage , irrigation and genotype x Irrigation interaction effects for water-use-efficiency. More modern cultivars produced 3-4kg/mm more grain than older cultivars.

(iv) Cultivars in zero-tillage had higher water-use-efficiency and higher yield, particularly in drought conditions, than under conventional tillage

Source of Variation	Mean Squares
Year	205.79***
Genotype	602.49***
Tillage	342.77***
Irrigation	283.75***
Genotype x Tillage	17.59ns
Genotype x Irrigation	39.86**
Genotype x Tillage x Irrigation	21.84ns

Table 1. Mean squares from analysis of variance for yield of wheat genotypes

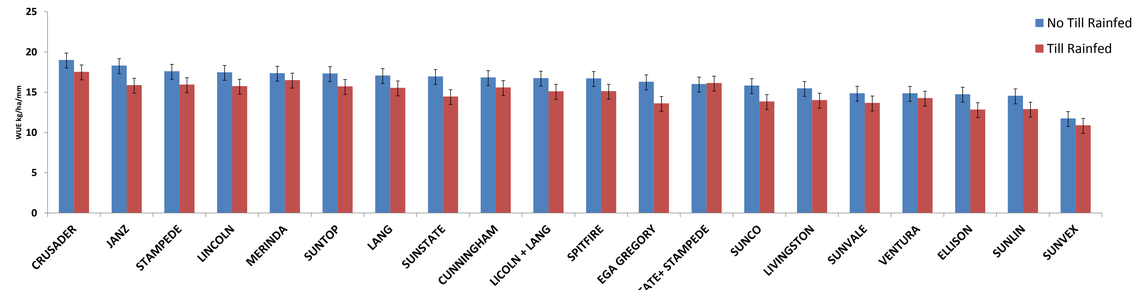

Fig 1. Water-use efficiency among genotypes in no-tillage and full tillage environments

GENOTYPE	NO TILL RAINFED	TILL RAINFED
SUNSTATE + STAMPEDE + JANZ	3842	3167
STAMPEDE	3913	3042
SUNSTATE+ STAMPEDE	3431	2988
LINCOLN	3602	2917
SUNTOP + SPITFIRE	3271	2858
JANZ	3735	2833
SUNTOP	3569	2779
SPITFIRE	3221	2729
LICOLN + LANG	3521	2665
SUNSTATE	3310	2658
LANG	3483	2652
LICOLN+LANG+SUNSTATE	3308	2638
EGA GREGORY	3483	2408
EGA GREGORY + VENTURA	2965	2342
VENTURA	2800	2077
Lsd (No till rainfed and Till rainfed)	188.2	

Table 2. Yield (kg/ha) performance of mixtures versus pure stands in no-tillage and full tillage rainfed environments.

Conclusion

(i) Physiological traits linked to improved yield and WUE could be targeted to improve wheat yield under drought stress in north-western NSW.

(ii) Mixtures have the potential to increase yield as well as buffer drought effects. If more water-use-efficient cultivars are deployed in mixtures in zero-tillage systems then wheat yield can be improved under limited moisture

Reference

Acuña, T. B., Lisson, S., Johnson, P., & Dean, G. (2015). Yield and water-use efficiency of wheat in a high-rainfall environment. Crop and Pasture Science,66(5), 419-429.

Nelson G, RosegrantM, Palazzo A, Gray I, Ingersoll C, Robertson G, Tokgoz S, Zhu T, Sulser T, Ringer C, Msangi S, You L (2010) Food security, farming and climate change to 2050: Scenarios, results, policy options. International Food Policy Research Institute, Washington, DC.

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