Genetic control of grain quality in bread wheat (*Triticum aestivum* L.) grown under a range of environmental conditions

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By

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List of Abbreviations

AFLP : Amplified fragment length polymorphism

CIM : Composite interval mapping

DArT : Diversity array technology™

DH : Doubled haploid

GMP : Gluetenin macropolymer

GSP : Grain softness protein

Ha locus : Hardness locus

HMW-GS : High molecular weight-glutenin subunits

LMW-GS : Low molecular weight-glutenin subunits

LOD : Logarithm of the odds

MAGIC : Multiparent advanced generation inter cross

MAS : Marker assisted selection

MVWGAIM : Multivariate whole genome average interval mapping

NaCl : Sodium chloride

NAM : Nested association mapping

NIR : Near infrared reflectance

PCR : Polymerase chain reaction

PSI : Particle size index

QTL(s) : Quantitative trait locus/loci

RAPD : Randomly amplified polymorphic DNA

RIL : Recombinant inbred line

RFLP : Restriction fragment length polymorphism

SDS : Sodium dodecyl sulphate

SE-HPLC : Size-exclusion high-performance liquid chromatography

SIM : Simple interval mapping

SNP : Single nucleotide polymorphism

SSR : Simple sequence repeats

TPP : Total polymeric protein

UPP : SDS-unextractable polymeric protein in total polymeric protein

WGAIM : Whole genome average interval mapping

Table of Contents

List of Tables

List of Figures

List of Appendices

Abstract

Abiotic stresses including high temperatures and moisture deficit are detrimental to bread wheat production. Under abiotic stresses, characteristics such as yield, growth rate, gene expression and quality are affected and responses might involve interaction of many genes. Most studies on the impact of abiotic stresses such as high temperatures and moisture deficit have concentrated on effects on yield and agronomic traits with less work being done on grain quality. This project focussed on the end-use quality of wheat grain produced under a range of field production conditions including high temperatures and water shortages, using two mapping populations, Gladius/Drysdale and RAC875/Kukri. Gladius, Drysdale and two pairs of backcross derivatives having Wyalkatchem and RAC1262A as recurrent parents were also studied under normal and heat stress conditions in a glasshouse experiment. Of the backcross derivatives, one line of each pair has a *Gpc-B1* (high grain protein content) gene introgression and the other does not. Field trials were conducted in Australia and Mexico and the glasshouse experiment was conducted in Australia. For the glasshouse experiment, Gladius showed more heat tolerance with no significant decrease in grain weight compared to Drysdale. The backcross derivatives with the introgression segment had higher grain protein content, percentage unextractable polymeric protein and accelerated senescence than ones without the segment. Grain weight and senescence were severely affected by heat stress. Quality analysis of field grown material involved sequential assessment of grain, flour, dough and baked product characteristics. Stress conditions increased protein content, decreased yield, grain thickness, width and increased dough development time compared to the control. The exposure to heat stress resulted in an increase in loaf volume compared to the control experiment. Genetic linkage maps were constructed for the Gladius/Drysdale population and used for quantitative trait loci (QTL) analysis. Quantitative trait loci analysis detected several genomic regions associated with quality traits under a range of conditions including drought and heat stress in both populations. Some of the traits were associated with known phenology and quality genes, some QTLs detected have been reported in other studies but some QTLs were novel and had not been detected elsewhere. The novel QTLs detected under conditions involving heat and drought stress present opportunities for selection of lines that are able to maintain quality under these adverse conditions.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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