Genetic and Environmental Control of Yellow Pigment in Durum Wheat (*Triticum turgidum Durum)* in Australia

Submitted by

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A thesis submitted for the fulfilment of the requirements of a

Doctor of Philosophy

Faculty of Sciences
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Discipline of Plant Breeding and Genetics
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August 2012

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Michael Quinn

August 2012

Table of Contents

Acronyms Used in this Thesis

AACC = American Association of Cereal Chemists

ABA = Abscisic acid

AGT = Australian Grain Technologies

ANOVA = Analysis of Variance

BLUE = Best linear unbiased prediction

BSA = Bulk segregant analysis

CIELAB= Commission Internationale de l'Eclairage L* (brightness) a* (red colour) b* (yellow colour)

HPLC = High pressure liquid chromatography

MAS = Marker assisted selection

MEP = 2-C-methyl-D-erythritol 4-phosphate

MRT = Multiplex ready technology

NIR = Near infra-red reflectance spectroscopy

NSW = New South Wales

NVT = National Variety Trials

PPO = Polyphenol oxidase

QTL = Quantitative trait loci

ReML = Restricted Maximum likelihood Ratio

SA = South Australia

SARDI = South Australian Research and Development Institute

SSD = Single seed descent

SSR = Simple sequence repeat

TGW = One thousand grain weight

UA = University of Adelaide

YP = Yellow pigment

YP/grain = Yellow pigment content per grain

Acknowledgments

I would like to sincerely thank my principal supervisor Associate Professor Daryl Mares and my co-supervisors Dr Stephen Jefferies and Associate Professor Glenn McDonald, who have taught me a great deal about scientific research, to think critically and helped me to vastly improve my writing skills. I would also like to thank Daryl and Steve for the opportunities provided to me while under their employment at The University of Adelaide (UA) and at Australian Grain Technologies (AGT) respectively.

I would like to thank the staff of Daryl Mares' Cereal Biochemistry laboratory at UA for their help and support. In particular I would like to thank Dr Robert Asenstorfer who was like a supervisor and taught me a lot about interpretation and presentation of data. Of the Cereal Biochemistry staff I'd particularly like the thank those who worked on the Durum Germplasm Development Program, in particular Luke Peterson and Cameron Mares, who helped immensely with sowing and harvesting field trials by hand, milling wholemeal samples, and with many yellow pigment extractions. I'd like to thank and acknowledge Imelda Soriano for the contribution of her unpublished data which is presented in the discussion of Chapter 4.

I would like to thank Professor Diane Mather and the staff of Diane's molecular marker lab, in particular Julien Bonneau and Dr Genet Mekuria, for the genotyping of populations and especially to Julien for assistance with interpretation of the data.

I would like to thank my manager Dr Haydn Kuchel and AGT for the opportunity to spend time at work to complete my thesis. I am also extremely grateful to the AGT staff at Roseworthy, Britt Kalmeier, Cassandra Bell, Daniel Vater, Dion Bennet, Jake Shultz, James Edwards, Jason Reinheimer, Kath Kuchel, Phil Keatley, Robert Raymond, Rowan Prior, Simeon Hemer, Stacey Bell, Stuart Milde and Susan Edlington, who have assisted me with my work duties while I completed my thesis.

I would like to thank the Grains Research and Development Corporation (GRDC) for their financial support of the project.

Finally, I would like to thank my beautiful and supportive fiancée, Bettina Downing, and my family, Daniel, Martin, Imelda and in particular my Mum and Dad, for their love and support. So much of what I been able to achieve and so much that is good in my life has come from them. From my father I have been given a love of science and agriculture and from my mother the support and confidence to peruse whatever it is I am interested in and makes me happy and the belief that I am capable of achieving my goals. From what they have taught me, to what they have made possible through their belief in me, to the sacrifices they have made for my welfare and education and so much more; it is all greatly appreciated.

Abstract

Environmental and genetic control of grain yellow pigment (YP) content of Australian durum cultivars has been investigated using large genotype x environment (including controlled environments) data sets and 2 large bi-parental recombinant inbred line durum wheat populations respectively.

Non-genetic variation in YP concentration was shown to be highly complex. This complexity was simplified by showing that final YP concentration is a function of the negative relationship between YP concentration and thousand grain weight (TGW), possibly due to starch dilution, and the total YP content synthesised per grain (YP/grain). Non-genetic variation in YP/grain was, not surprisingly, shown to be dependent on final TGW; however, it was also shown to be independent of TGW. Limited plant available water during grain filling resulted in both lower YP/grain and lower TGW; the net result was a modestly higher grain YP concentration. An hypothesis based on endosperm cell number that attempts to explain the observations is proposed and the implications of non-genetic control of YP for breeding programs discussed.

YP concentration and YP/grain were shown to be multi-genic traits and in both populations examined there was evidence of transgressive segregation. QTL on chromosomes 7AL, 7BL, 7BS, 6B, 1A and 3B in Wollaroi/Tamaroi and 7AL, 7BL, 7BS, 6BL, 6BS, 1A and 3B in WID22221/Tamaroi were additive and together explained >50% and >40% of the phenotypic variation respectively with 7AL and 7BS being the most important. Allelic variation at *Psy1-A1*, encoding phytoene synthase, was identified in both populations but contrary to expectation was not

associated with significant differences in YP phenotype. Rather the effect of chromosome arm 7AL appeared to be contributed by a QLT located proximal to *Psy1-A1*. In contrast, association between YP concentration and allelic variation at *Psy1-B1*, which has been identified in international germplasm, was confirmed in Australian durum wheat.