



Heat tolerance QTL in wheat

Nick Collins, University of Adelaide

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Impact of heat waves on wheat yield in southern Australia

Growth Stage	Climatic variable	Unit	Effect (kg/ha)	Effect %
Flowering	Rainfall	mm	22	1
	Average daily minimum	°C	-161	-6
	Average daily maximum	°C	-371	-15
	Days >30 °C	number	-379	-15
	Days >35 °C	number	-837	-33
	Average Temperature	°C	-490	-19
Grainfill	Rainfall	mm	23	1
	Average daily minimum	°C	-125	-5
	Average daily maximum	°C	-225	-9
	Days >30 °C	number	-130	-5
	Days >35 °C	number	-179	-7
	Average Temperature	°C	-244	-10

Data used from 600 southern-Australian NVTs, 2005-2010

Paul Telfer et al. 2015; AGT

Greenhouse/chamber assays

Greenhouse



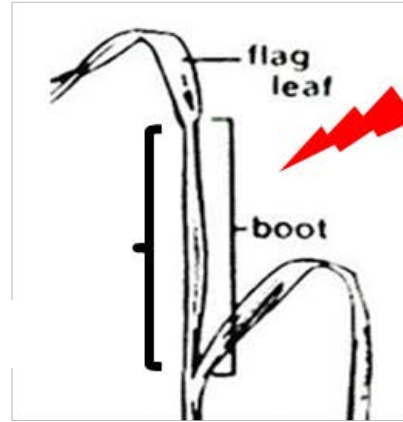
Chamber; 3 days, 37/27 °C day/night



Our two greenhouse/chamber assays

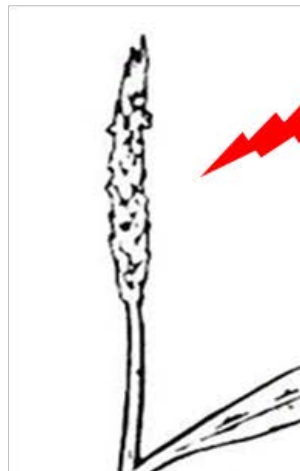
Floret fertility

3 to
11 cm

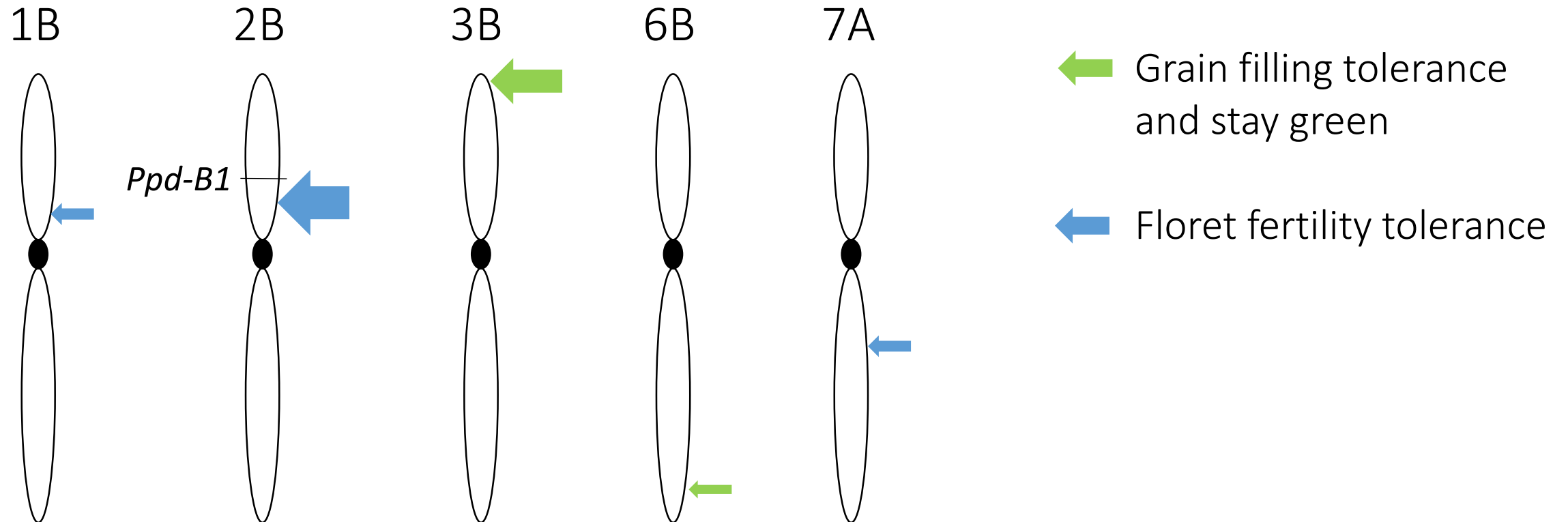


Grain size

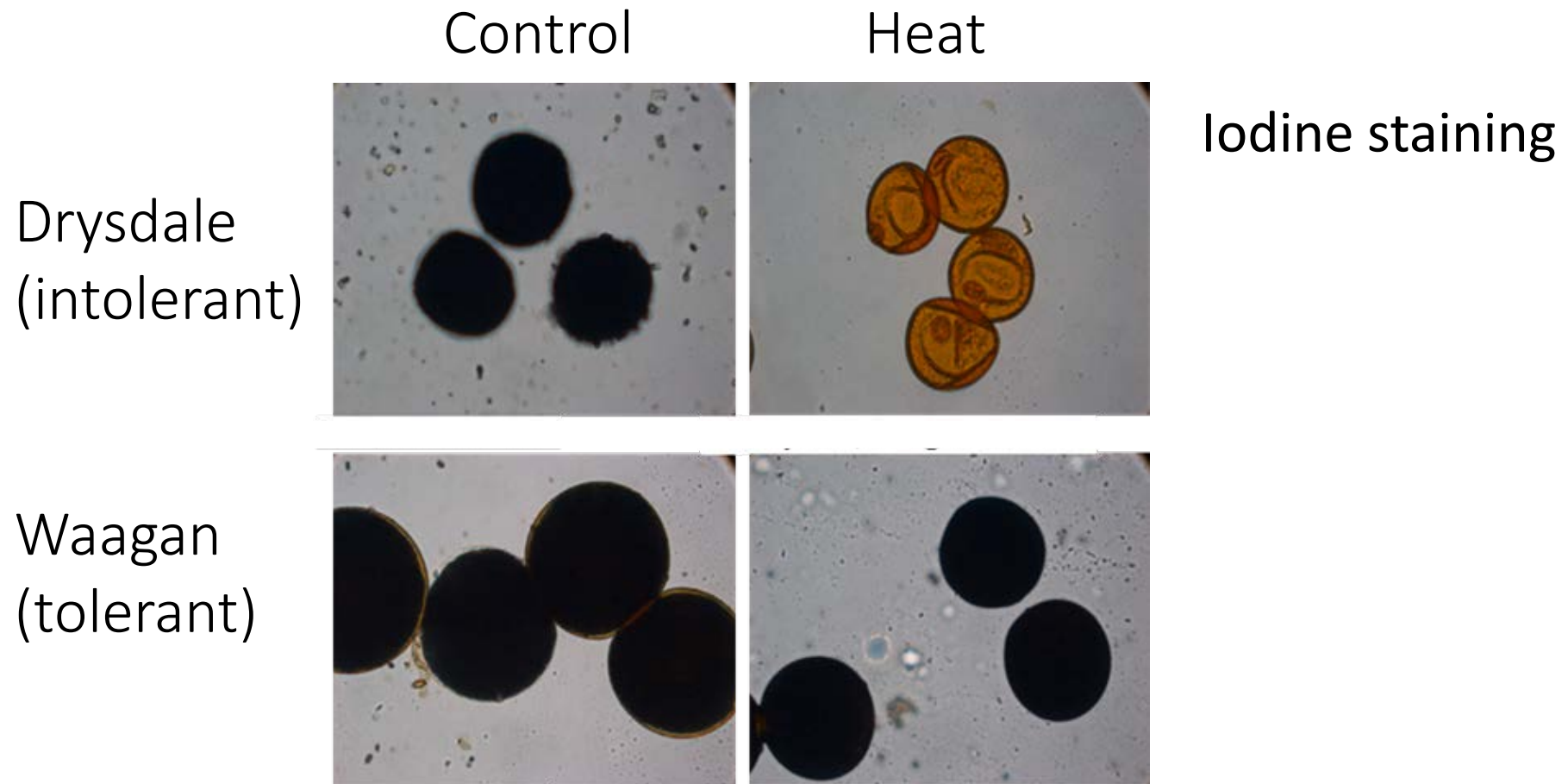
10 days
after
anthesis



Waagan x Drysdale heat tolerance QTL

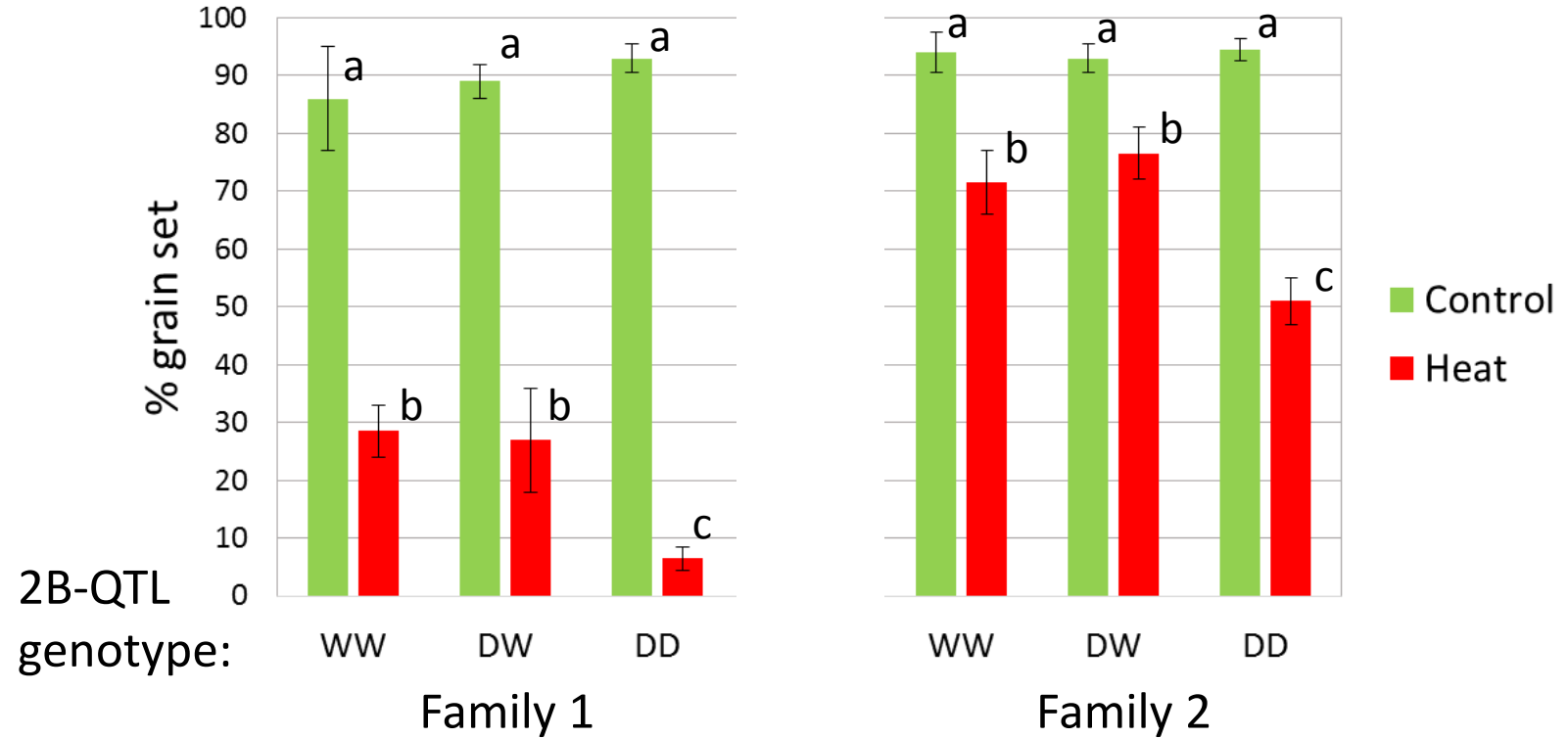
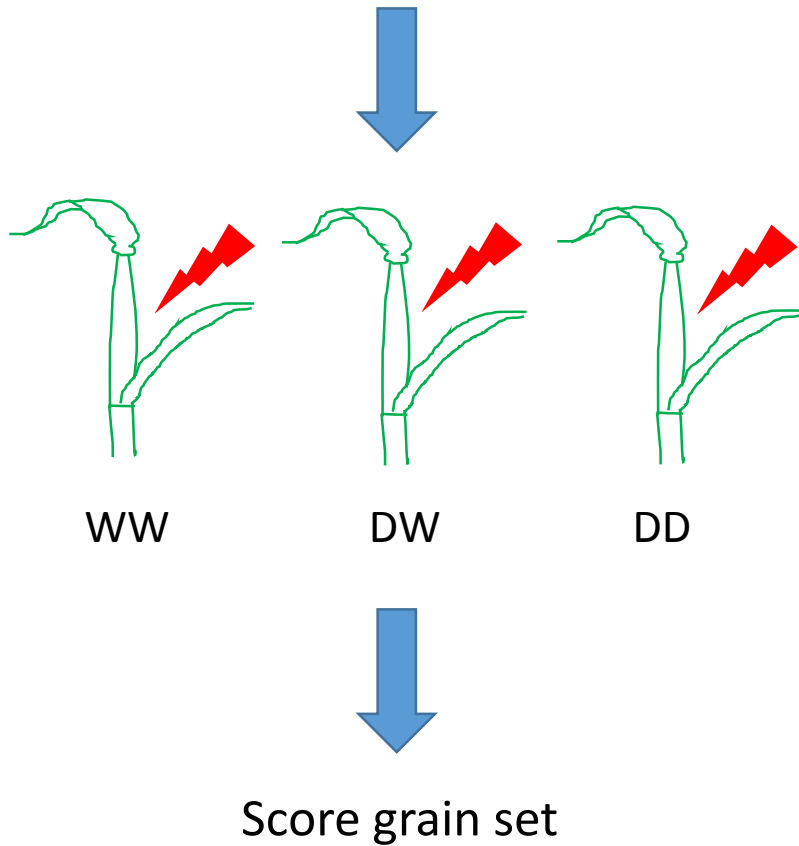


Floret sterility is associated with an absence of starch in mature pollen grains

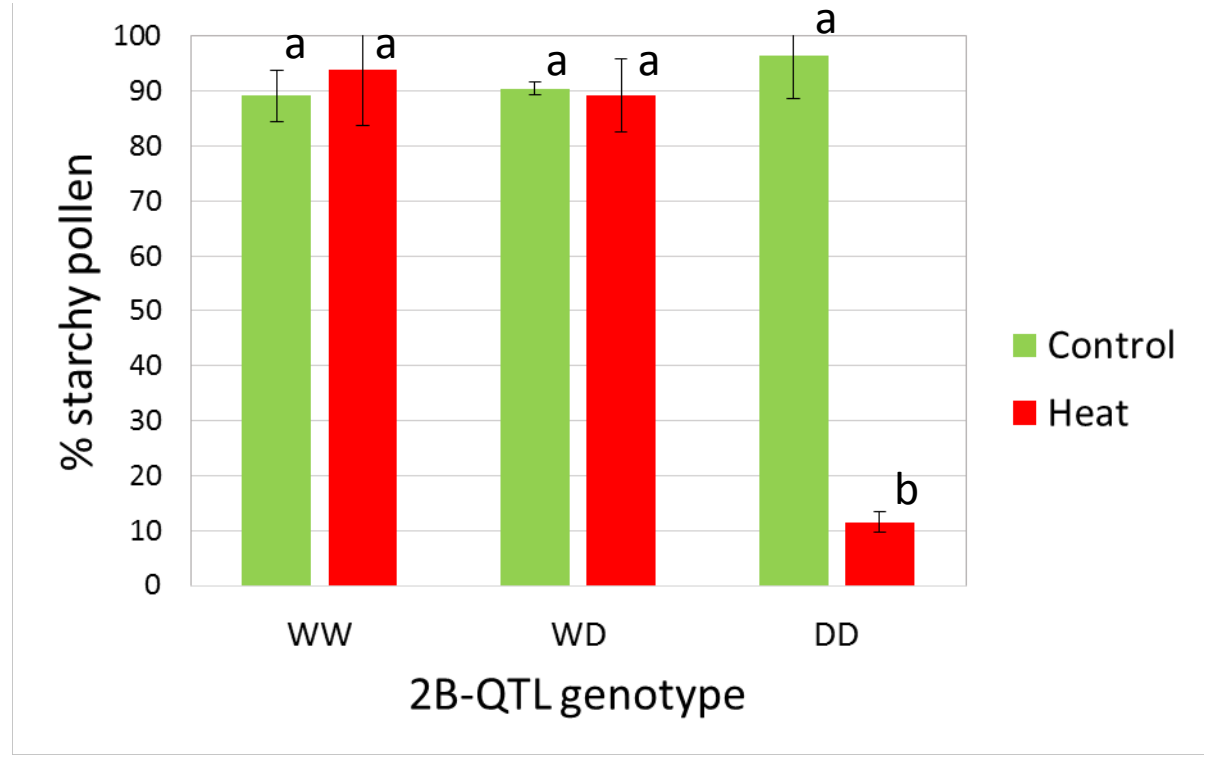
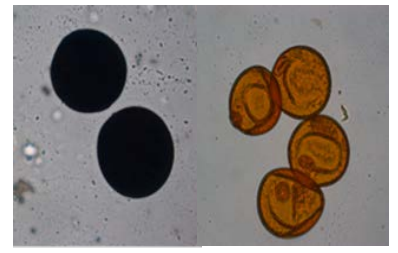
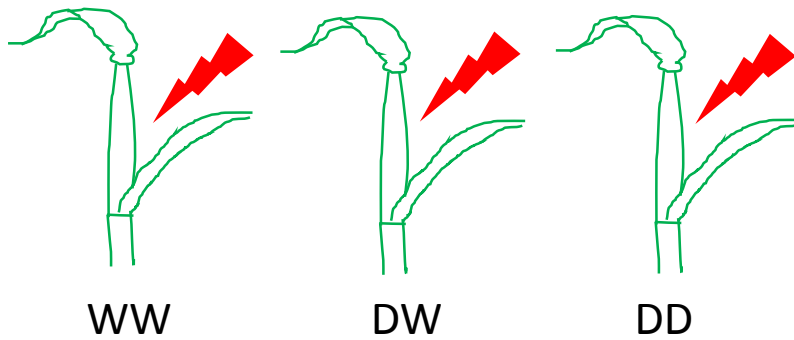


Dominance of the 2B-QTL (grain set)

DW (heterozygous RIL plant) \otimes

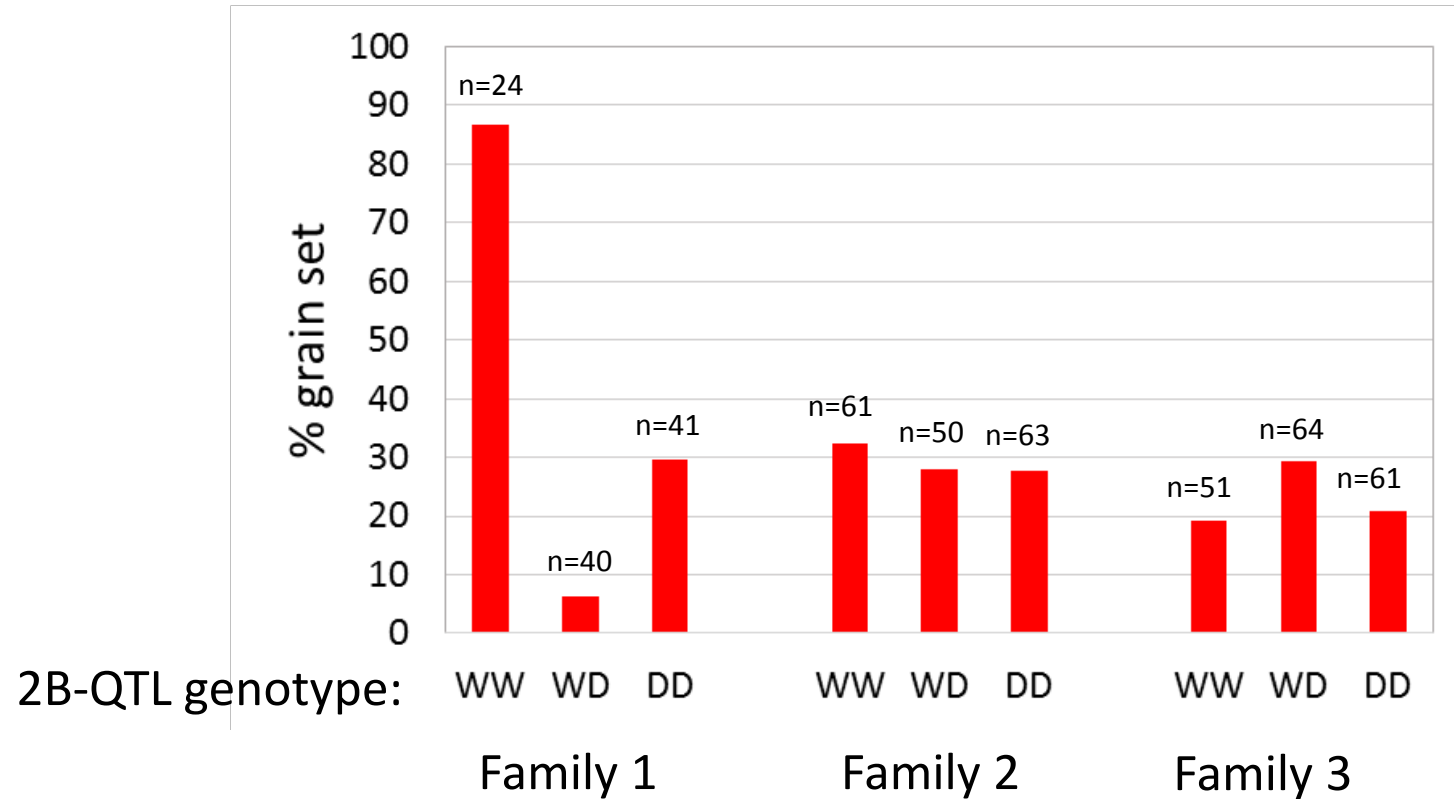
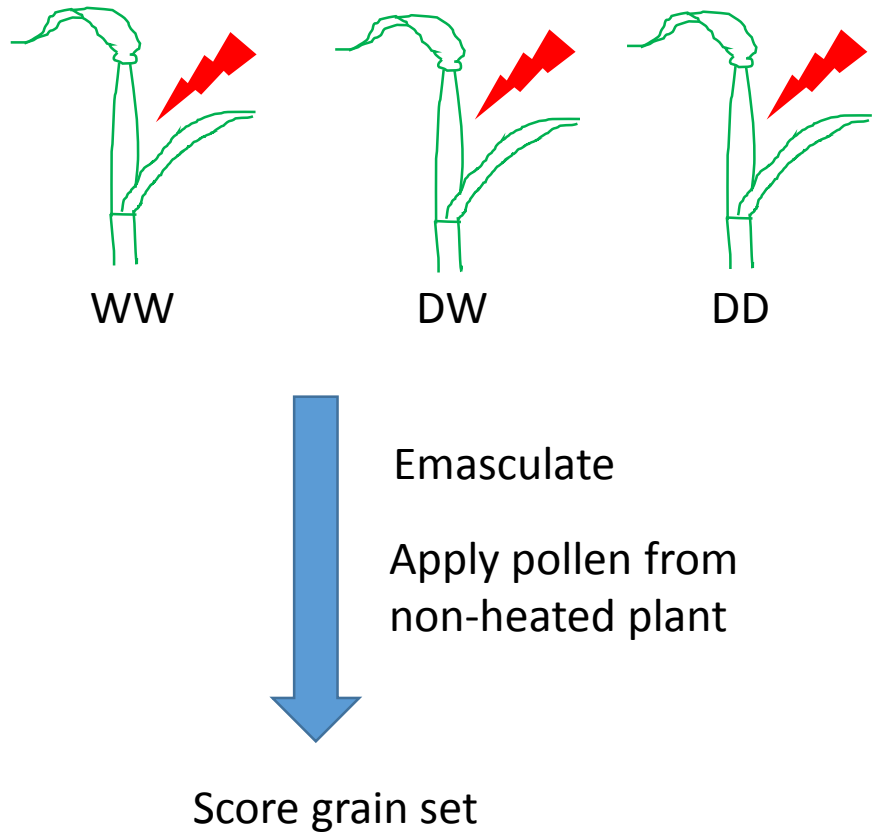


Dominance of the 2B-QTL (pollen)



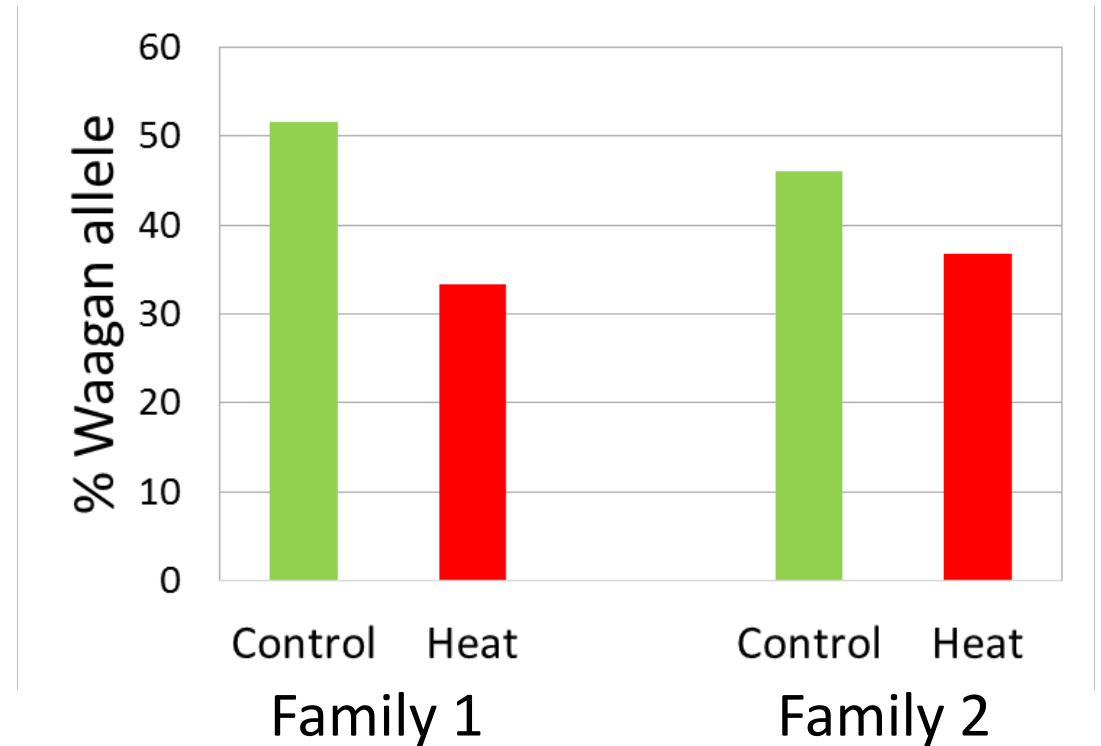
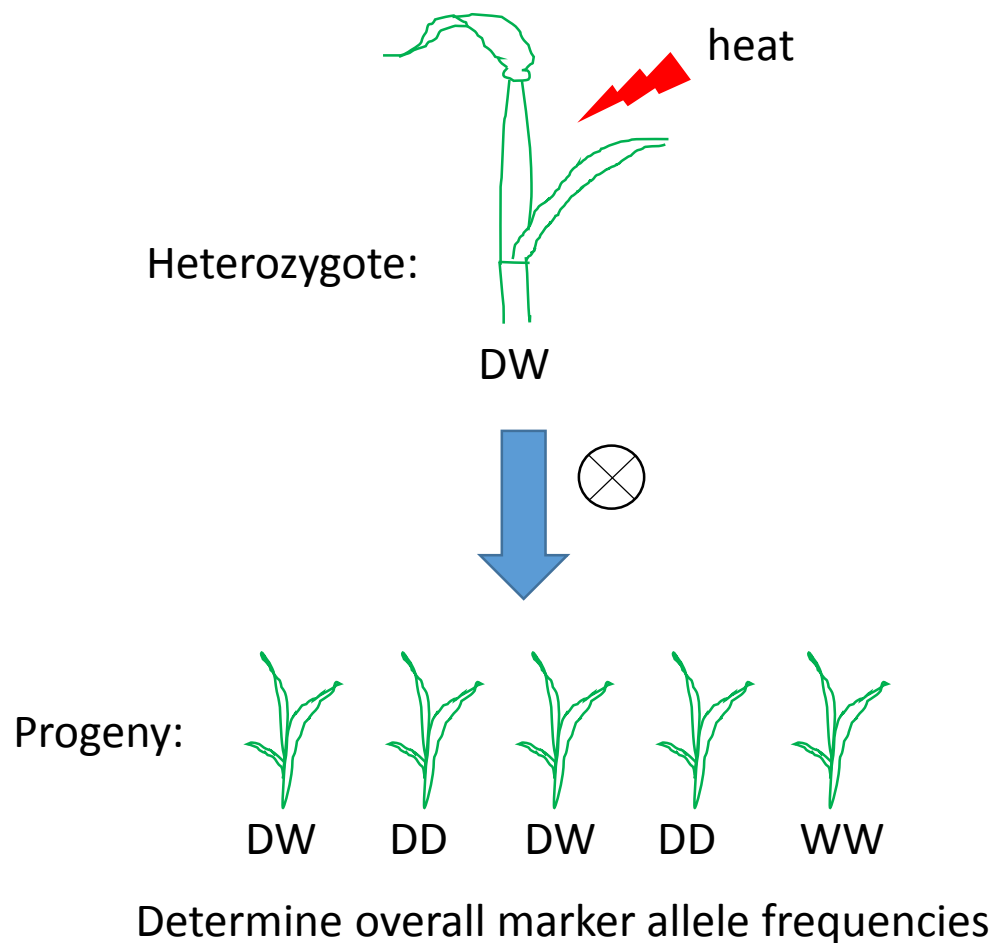
➤ Intolerance may result from a loss of gene function

Does the 2B-QTL tolerance affect female reproduction?



No indication that it does (or at least to the same extent as it does the pollen)

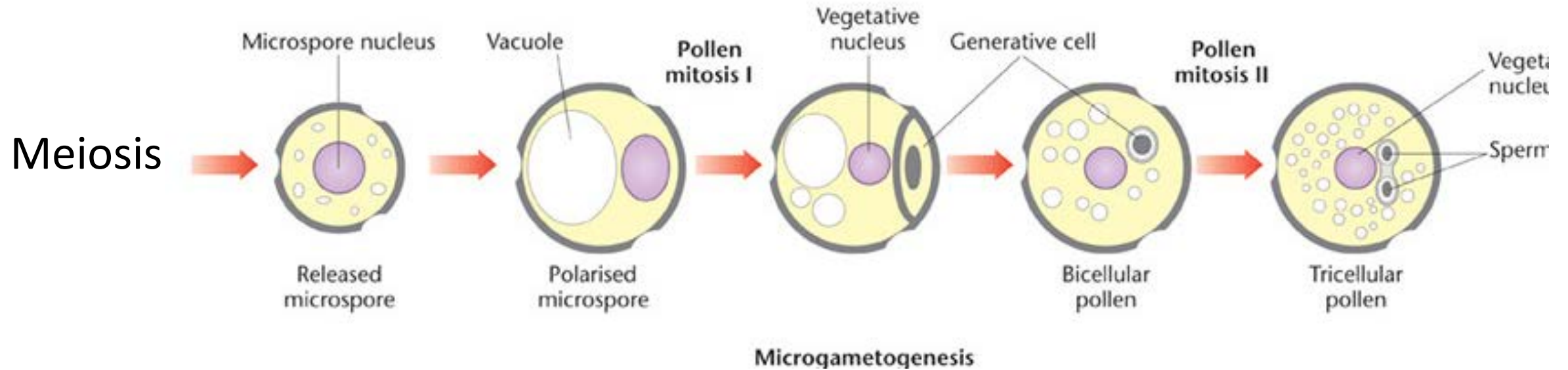
Is the 2B-QTL tolerance the result of gene expression in haploid cells?



No.

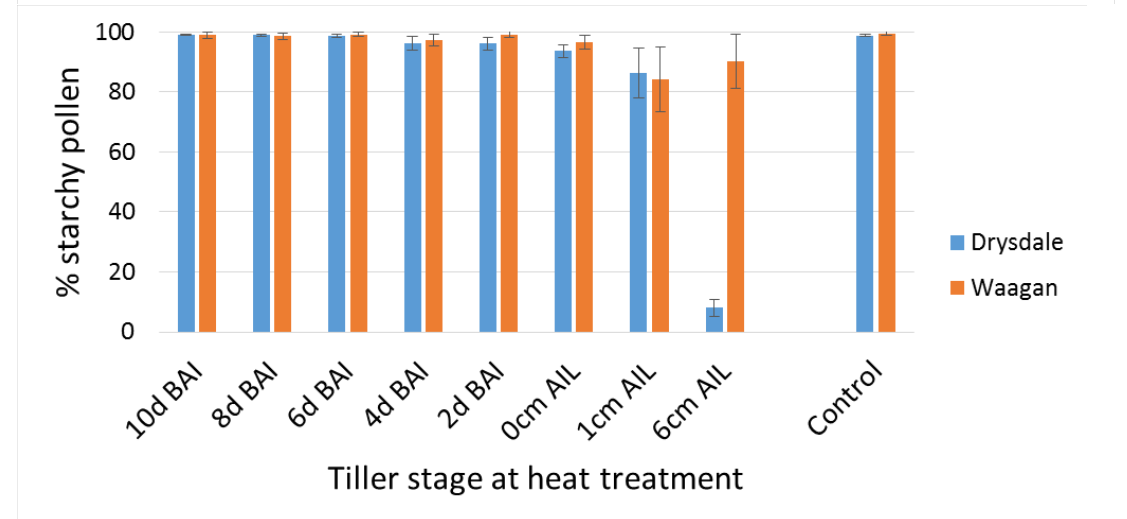
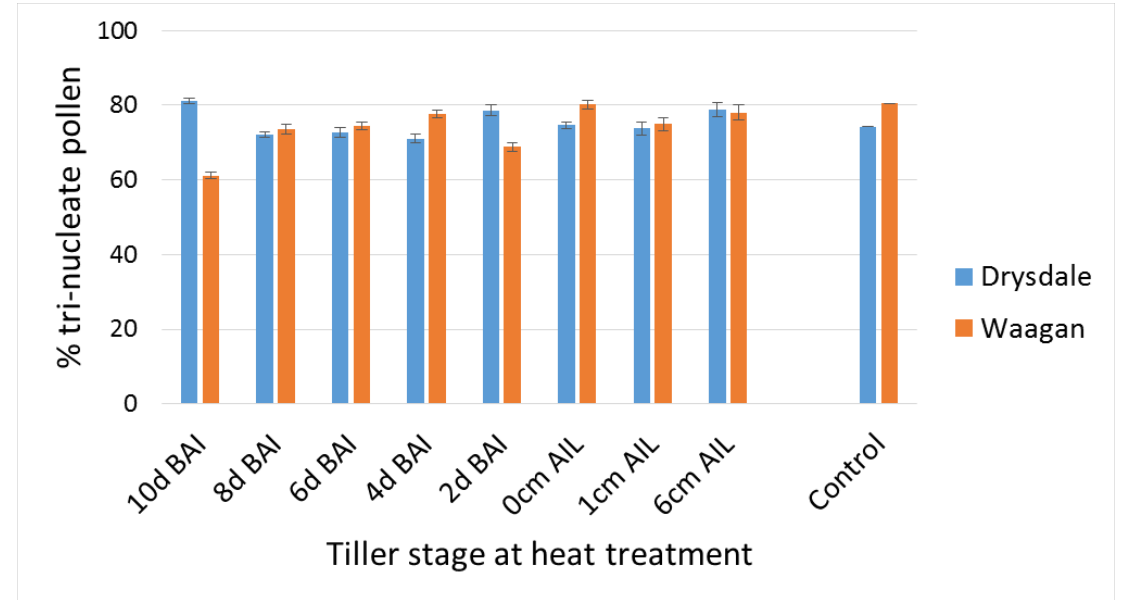
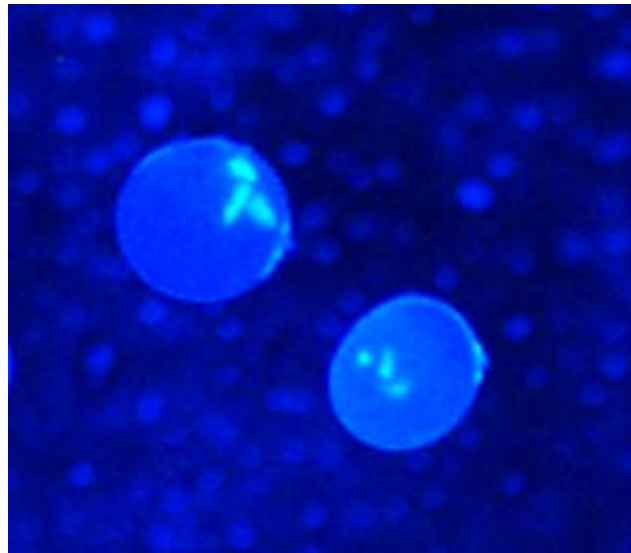
➤ Heat-stressing F_1 hybrids will not work as a selection tool for heat tolerance breeding

Mitotic divisions in (haploid) microspores



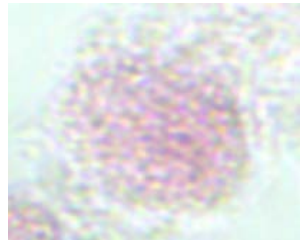
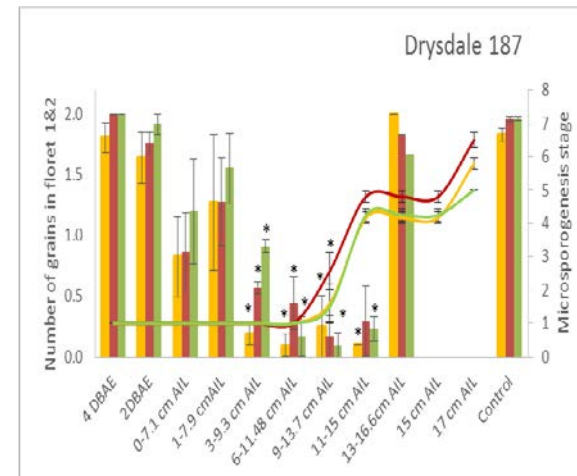
Mitotic divisions were not affected...

'Normal' tri-nucleate pollen (DAPI staining):

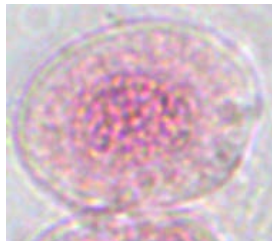


Susceptible stage in cv. Drysdale

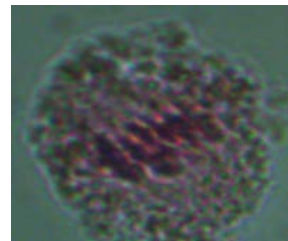
(80-90% of final spike length)



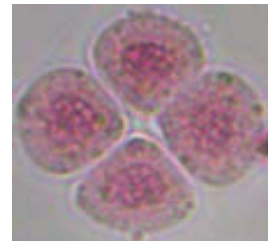
Pre meiosis



Early meiosis



Meiosis



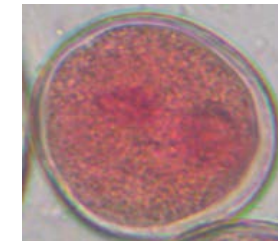
Tetrad



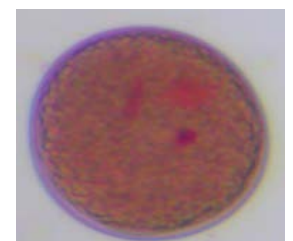
Early uninucleate



Late uninucleate



Binucleate



Trinucleate



Tapetum degradation normally begins



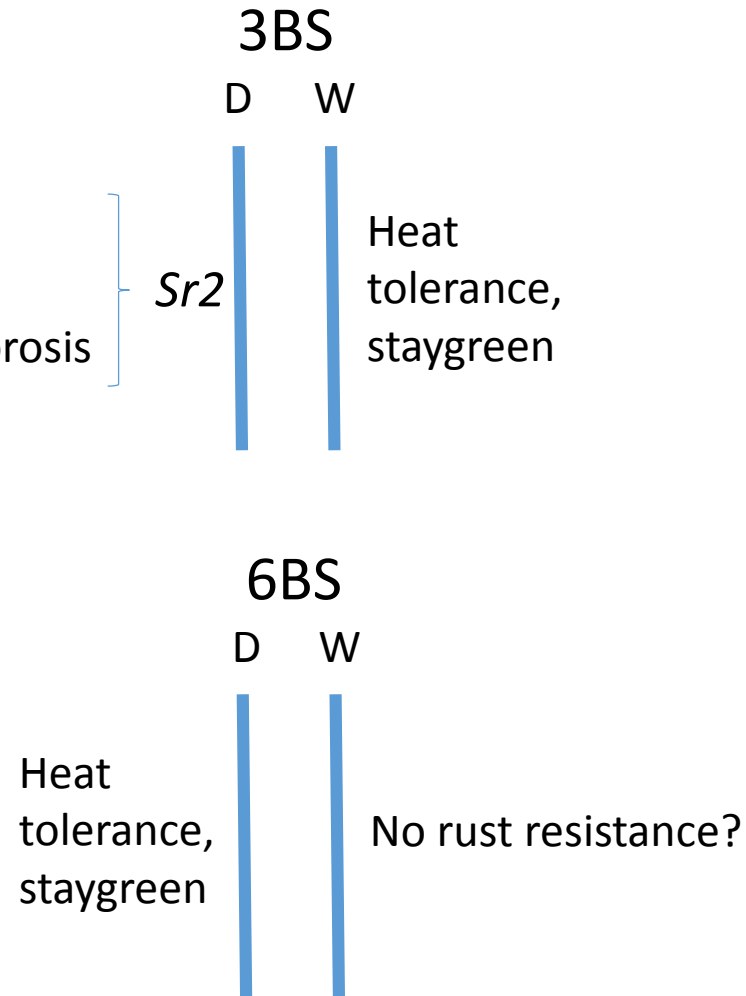
Starch accumulation normally begins

Tolerance is suspected as being the result of gene action in the tapetal cells

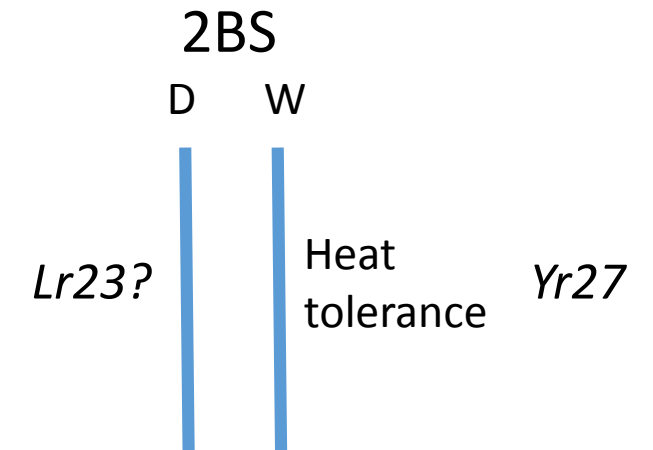
Linkage to rust resistance genes (Drysdale x Waagan population)

Grain filling tolerance

- Rust resistance
- Pseudo black chaff
- Heat induced seedling chlorosis



Fertility tolerance



ARC Industrial Transformation Research Hub for Wheat in a Hot and Dry Climate

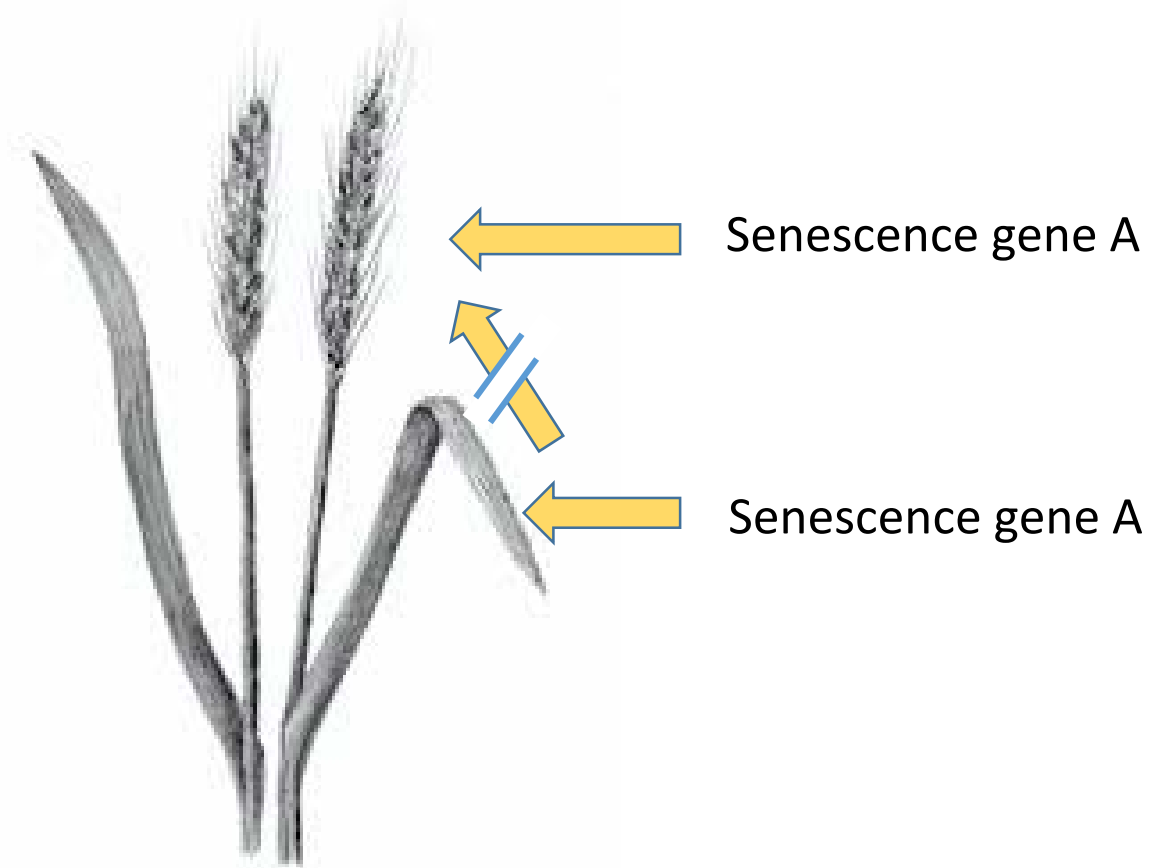
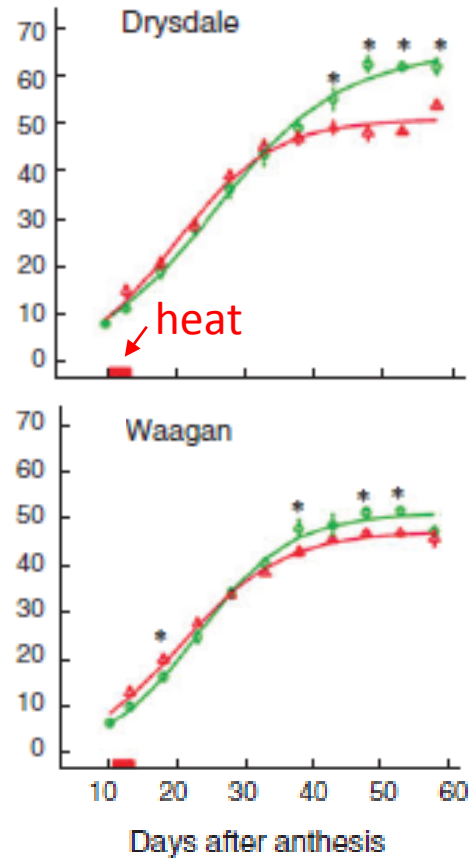
2016-2020

- Univ. Adelaide (ACPFGR), Univ. SA, Univ. Sydney
- GRDC
- AGT, Longreach, InterGrain

NILs for heat tolerance QTLs will be field-trialled under regular rain fed conditions.

Response to heat shock – senescence in the grain

Dry weight
per grain (mg)



Shirdelmoghanloo et al. 2016. *Functional Plant Biology* 43:919-930

Shirdelmoghanloo et al. 2016. *Acta Physiol Plant* 38:208

Acknowledgements



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