Genotypic variation in water soluble carbohydrate (WSC) and its contribution to yield in canola

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WSC roles in determining crop yield

WSC: Stored sugar in leaves, stem and pod wall that can be remobilized to grains and contribute to yield.

		
WSC	200-300 g/m^2 (Ruuska et al., 2006; Rebetzke et al., 2008)	100 g/m^2 in Europe No data in Australia
WSC/Yield	30-40%	0-10% in Europe
Genotypic variation	Yes (Ruuska et al., 2006)	??
Breeding traits	For drought tolerance (Rebetzke et al. 2008; Ruuska et al., 2006) For high yield potential (Foulkes et al., 2006)	?? How important is WSC in canola for drought tolerance? ?? Does WSC contribute to high yield potential?

Aims - to answer following questions

- Quantify the WSC difference in a wide range of genotypes;
- How much does WSC contribute to seed yield;
- Is WSC a useful trait for breeding drought resistant canola in the low rainfall environment and for improving yield potential in favourable conditions such as the high rainfall area.

The experiments

2009-2011

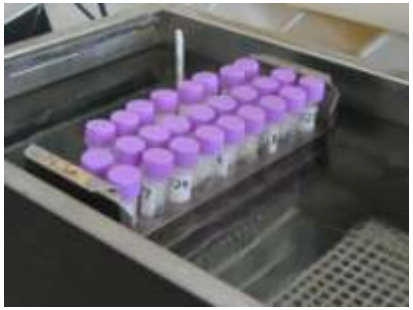
Genotypes

- IT canola (hybrid & OP)
- Hybrid conventional
- TT canola (hybrid & OP)

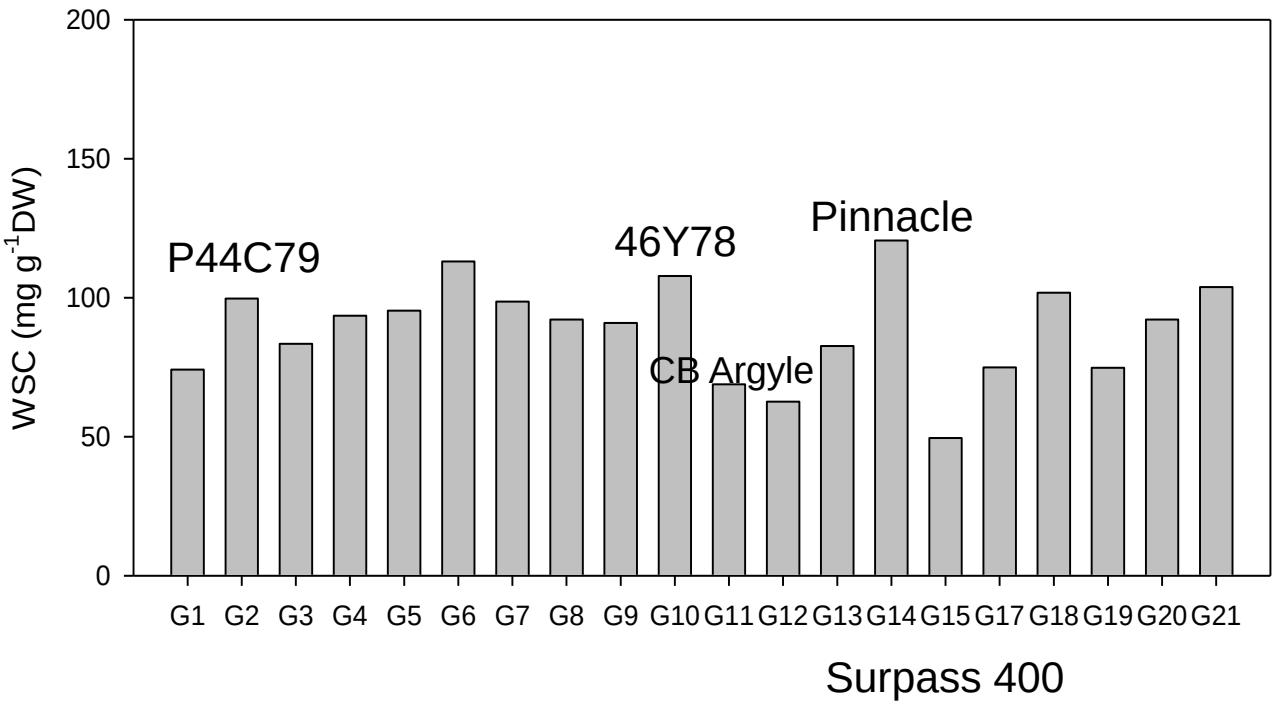
- Replicated 4 times
- Managed at optimal fertilization and weed management

Measurement of WSC

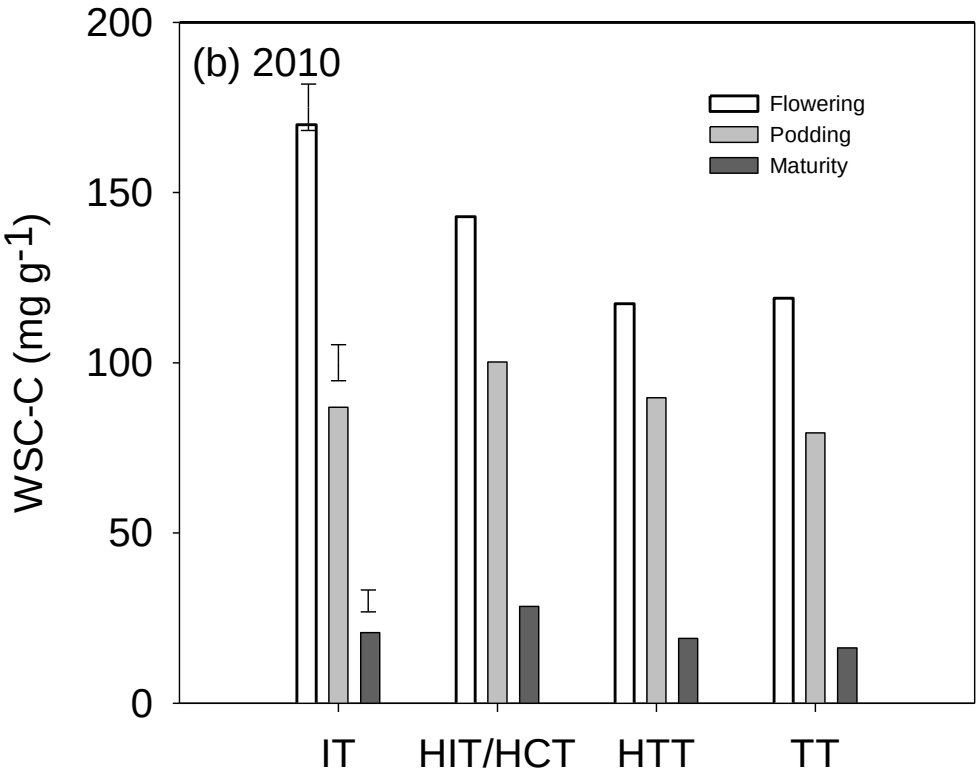
- Extraction
  - Extract with 8 ml 80% of ethanol at 80^{o}C and 8 ml distilled water at 60^{o}C
  - Anthrone method to measure WSC-C
- Biomass at flowering, pod filling and maturity
- WSC = [WSC-C]*Biomass
- Remobilized WSC=WSC at podding-WSC at maturity



WSC concentration at the end of flowering (2010)



The concentration of WSC



- Highest at flowering
- Decrease as crop develops pods
- <20 mg g^{-1} at maturity
- IT and hybrid canola had higher WSC-C than TT canola

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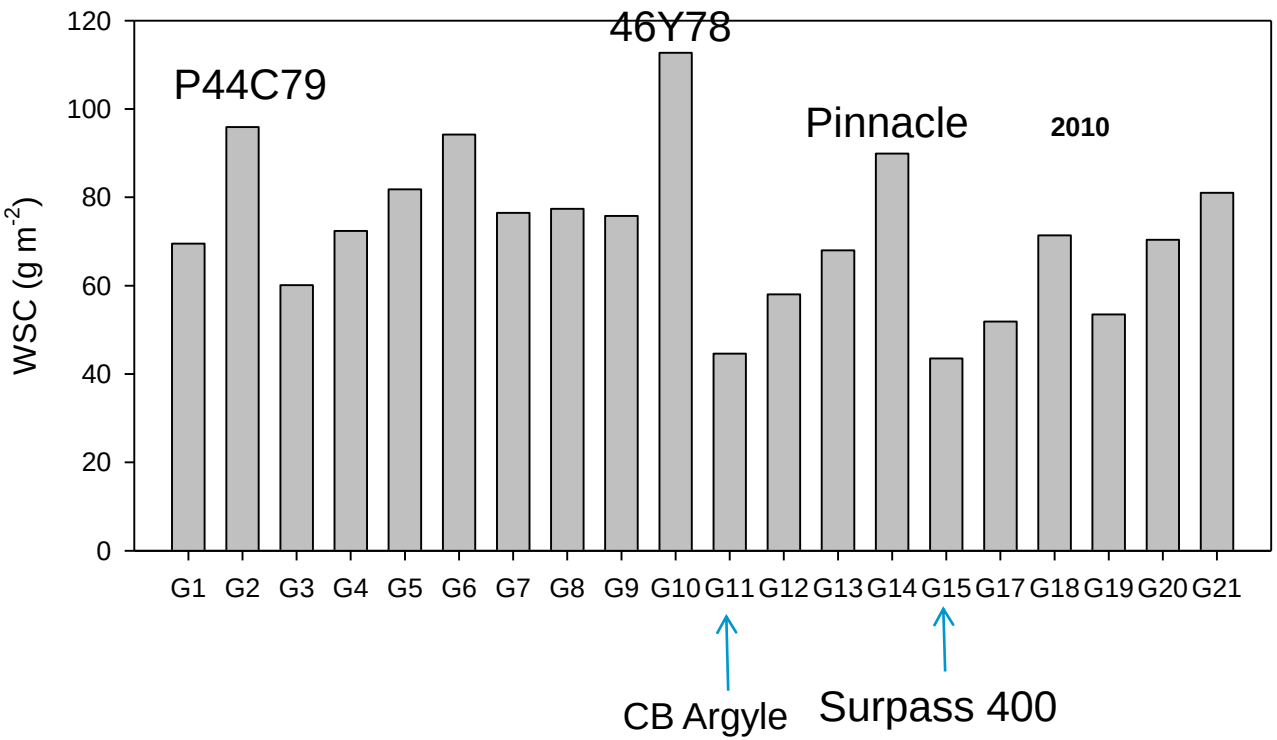
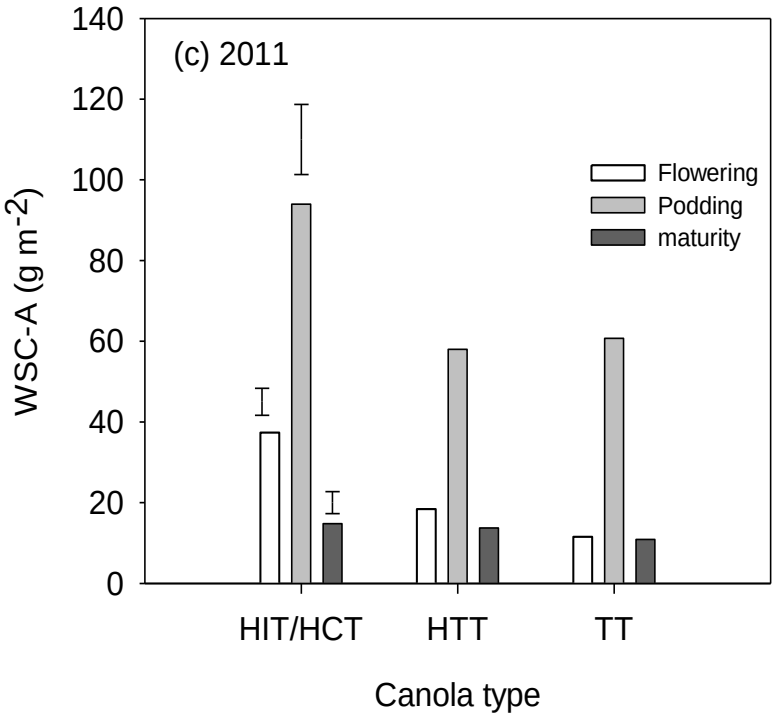
The amount of WSC at the beginning of podding

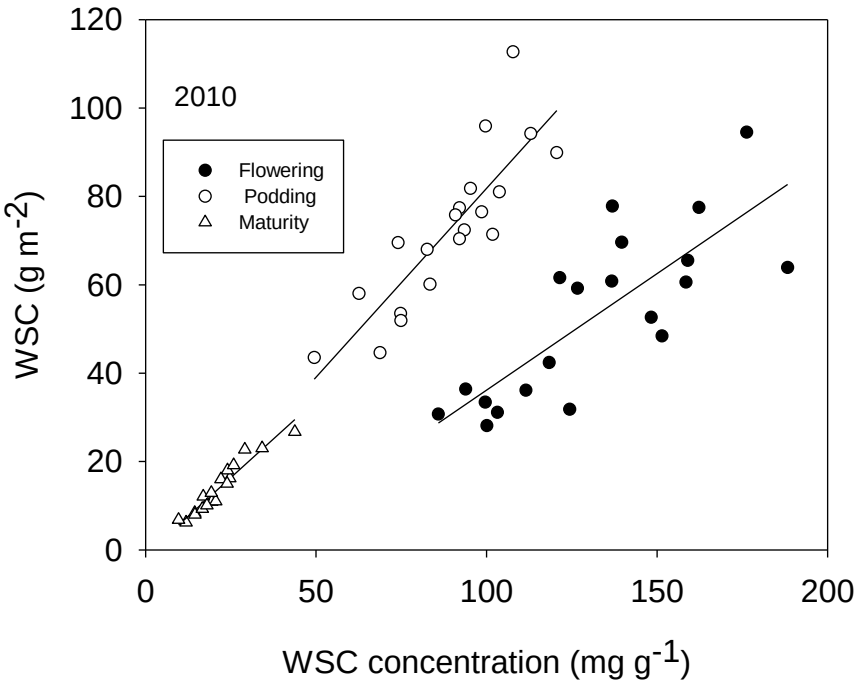


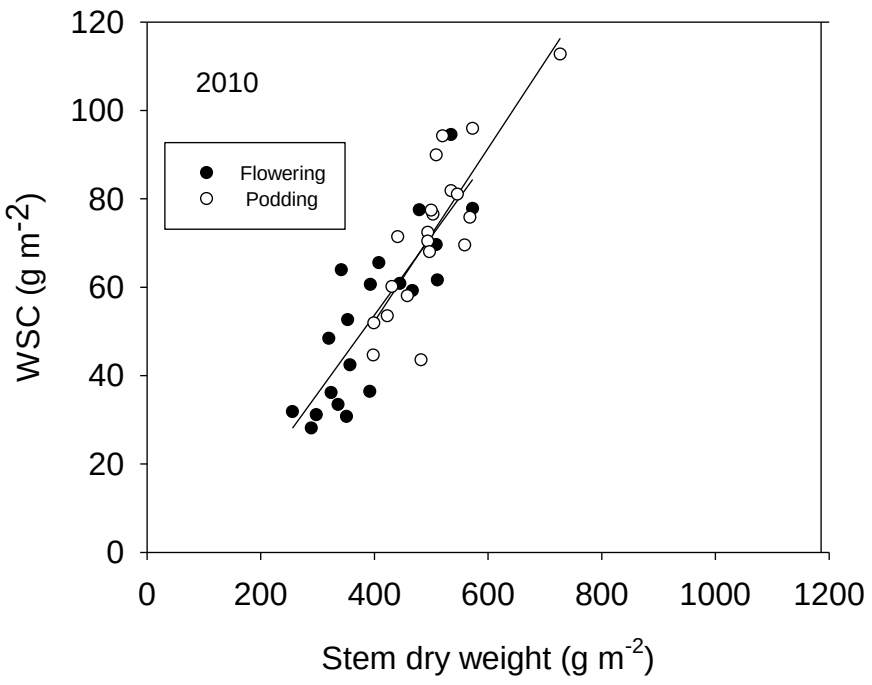
The amount of WSC



- Low at flowering
- Highest at the beginning of podding
- <20 g m^{-2}
- IT and CT had higher WSC than TT canola.

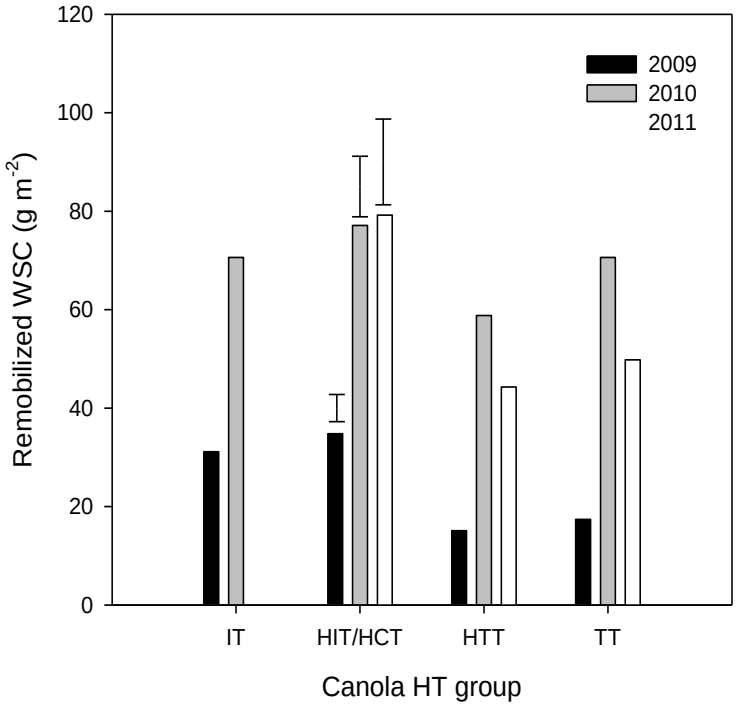
What determines WSC?

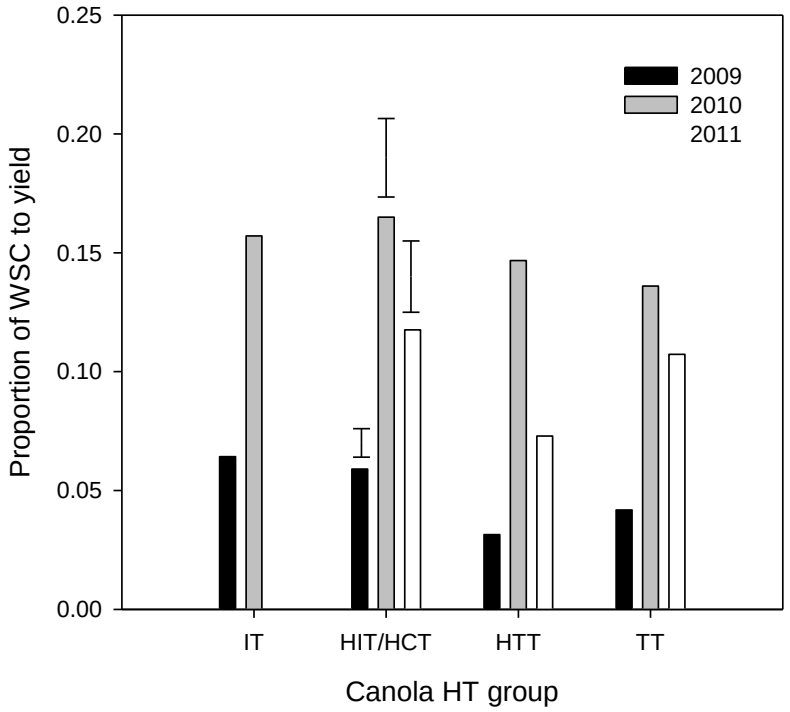




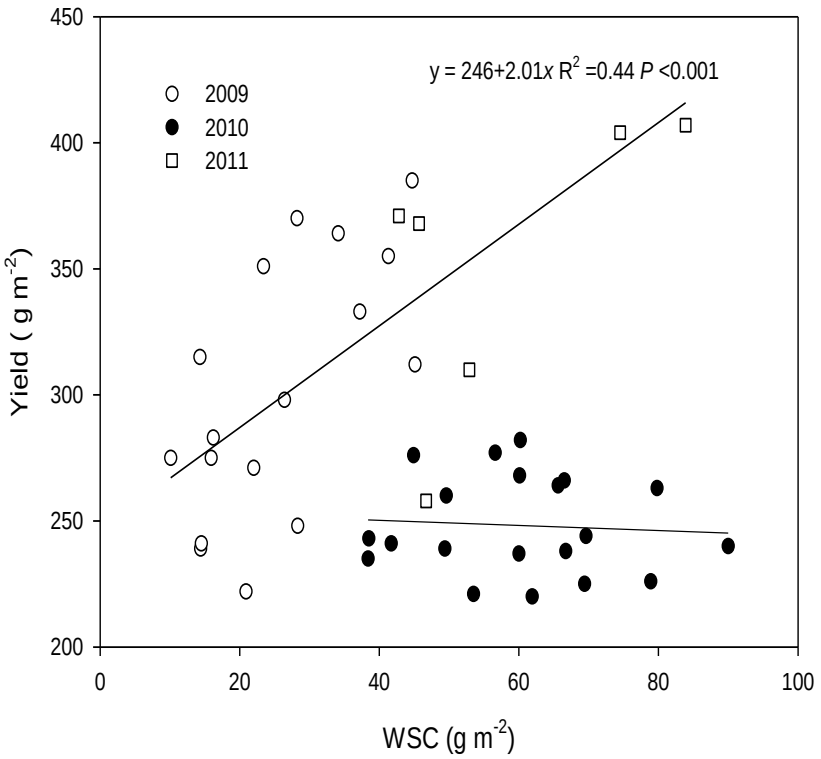
Remobilized WSC and its contribution to yield

IT & CT > TT canola





WSC and yield



- Linear relationship in 2009 and 2011
- No clear relationship in 2010 (drought years)

GxE interaction and heritability

Trait	δ^2_g	$\delta^2_{g.e}$	δ^2_{error}	$H_{single\ plot}$	$H_{Entry\text{-}mean}$
WSC-C at flowering	2.409**	3.732**	2.382	0.28	0.61
WSC-C at podding	1.363**	0.544^{ns}	1.299	0.43	0.81
WSC-C at maturity	0.037**	0.183**	0.393	0.06	0.26
WSC-A at flowering	199.86**	48.650**	55.270	0.66	0.90
WSC-A at podding	150.00**	21.900^{ns}	159.60	0.48	0.87
WSC-A at maturity	6.130**	6.180**	19.000	0.20	0.60
Maximum WSC transferred	129.20**	0.00^{ns}	172.20	0.43	0.87
Ratio of WSC to yield	0.00049**	0.00013^{ns}	0.00102	0.30	0.76

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Conclusion

	Canola	Canola
WSC (how much?)	100 g/m^2 in Europe	60-120 g/m^2 in Australia
WSC/Yield	Negligible 10% ? in Europe	5-20% contribution to yield.
Genotypic variation	??	Yes. Large genotypic variation and is inheritable.
Breeding trait	?? How important is WSC in canola under drought? ?? Does WSC contribute to high yield potential?	WSC is a potential trait for drought tolerance because of its high contribution to yield. However it needs to be considered in combination with other traits such early flowering. Yield is correlated to the WSC amount, indicating that it can be used as a trait to improve yield potential in the HRZ.

Acknowledgements

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